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Patent  
ATTY. DKT. AMAT/1931/MD/COPPER/DV

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of: Fusen Chen et al.  
Serial No.: 08/856,116  
Filed: May 14, 1997  
For: Reliability Barrier Integration  
For CU Application

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Group Art Unit: 2814  
Examiner: Bernard Souw

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JProctor

Assistant Commissioner of Patents  
Washington, D.C. 20231

CERTIFICATE OF MAILING  
37 C.F.R. 1.8  
I hereby certify that this correspondence is being deposited on November 22, 1999, with the U. S. Postal Service as First Class Mail in an envelope addressed to: Assistant Commissioner of Patents, Washington, D.C. 20231.  
11/22/99 B. Todd Patterson  
Date B. Todd Patterson

Dear Sir:

APPEAL BRIEF

Applicants submit this Appeal Brief to the Board of Patent Appeals and Interferences on appeal from the decision of the Examiner of Group Art Unit 2814 dated July 9, 1999, finally rejecting claims 1-8, 11-18, and 20-21. Please charge the fee of \$300.00 for filing this brief, and any additional fees to make this submission timely, to Deposit Account No. 20-0782/APPM/1931/KMT. A duplicate copy of this letter is enclosed. Three copies of this brief are submitted for use by the Board.

Real Party in Interest

The present application has been assigned to Applied Materials, Inc., 3050 Bowers Avenue, Santa Clara, California 95054.

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### **Related Appeals and Interferences**

Appellant asserts that no other appeals or interferences are known to the appellant, the appellant's legal representative, or assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

### **Status of Claims**

Claims 1-8, 11-18, and 20-21 are pending in the application. Claims 1-20 were originally presented in the application. Claims 8 and 9 were canceled by the Applicants, and Claim 21 was added during prosecution. Claim 19 was restricted and canceled without prejudice by Applicant during prosecution. Claims 1, 5, 15, 18, and 20 stand rejected under 35 U.S.C. § 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the art that the inventors, at the time the application was filed, has possession of the claimed invention. Claims 1-8, 11-18, and 20-21 stand rejected in view of a combination of references as discussed below. The rejection of claims 1-8, 11-18, and 20-21 is appealed. The pending claims are shown in the attached Appendix. No claims have been allowed.

### **Status of Amendments**

The claims in the Appendix include all amendments presented prior to the final rejection. Applicants filed a response after final rejection and the proposed amendments to the claims contained therein were not entered.

### **Summary of the Invention**

The invention generally provides a method and related apparatus for filling a feature with copper. The process comprises first forming a reliable barrier layer in the feature to prevent diffusion of the copper into the dielectric layer through which the feature is formed. One embodiment of the process for filling a feature formed in a dielectric comprises forming a generally conformal first barrier layer 16 over a patterned dielectric 12, removing the portion of the first barrier layer 16 formed on the bottom 22 of the feature 20, depositing a second barrier 24

comprising a material selected from a group consisting of Ta, TaN, TaSiN, TiSiN, and combinations thereof, and then filling the feature 20 with copper. (See page 6, lines 5-22; see also Example 1, page 12, line 22, to page 13, line 7, and Figures 2-6) An alternative embodiment of the process comprises depositing a first barrier layer 16 over a blanket dielectric layer 12, forming a feature 20 through both the barrier layer 16 and the dielectric layer 12, depositing a generally conformal second barrier layer 30 in the feature 20, removing the barrier layer 30 from the bottom of the feature 20, and selectively filling the feature 20 with copper. (See page 6, line 23, to page 7, line 11; see also Example 2, page 13, lines 8-16, and Figures 7-12).

### Issues Presented

1. Whether the Examiner erred in rejecting claims 1, 5, 15, 18, and 20 under 35 U.S.C. § 112, first paragraph, as containing subject matter which was not described in the specification.
2. Whether the Examiner erred in rejecting claims 1-8, 11-14, and 21 under 35 U.S.C. § 103(a) as being unpatentable over *Taguchi et al.* in view of *Ho et al.*, and further in view of *Barnes et al.* and *Bunshah*, on grounds that the combination of references shows each feature of the claimed invention.
3. Whether the Examiner erred in rejecting claims 15-18 and 20 under 35 U.S.C. § 102(b) as being anticipated by *Taguchi et al.*, on grounds that the reference discloses all elements of the claimed method for depositing Si<sub>x</sub>N<sub>y</sub> layers.

### Grouping of Claims

Pending claims 1-8, 11-18, and 20-21 do not stand or fall together for all arguments presented by Applicant. Applicant's first argument relates to claims 1, 5, 15, 18, and 20, and claim 1 is representative of the claims. Applicant's second argument relates to claims 1-8, 11-14, and 21, and claim 1 is representative of the claims. Applicant's third argument relates to claims 15-18 and 20, and claim 15 is representative of the claims.

**ARGUMENT**

**I. THE EXAMINER ERRED IN REJECTING CLAIMS 1, 5, 15, 18, AND 20 UNDER 35 U.S.C. § 112, BECAUSE THE TERM “FEATURE” IS NOT NEW MATTER AND IS DESCRIBED IN THE SPECIFICATION.**

Claims 1, 5, 15, 18, and 20 stand rejected under 35 U.S.C. § 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. The Examiner asserts that replacement of “hole” with “feature” essentially adds new matter since the substituted “feature” has broader interpretation than hole, and the subject matter “feature” was not describe in the specification.

Applicants disagree that the term “feature” is new matter since the specification teaches at page 6, lines 20-22, at page 7, lines 8-11, and at page 13, lines 8-16, that the present invention encompasses the filling of features. Additionally, “hole” is a broad term used for defining an absence of material that has no definite shape or functionality, and is synonymous with terms such as aperture and feature. For example, features such as contacts, vias (of Examples 1 and 2), interconnects, trenches, and dual damascenes are essentially holes of variable shapes between and through deposited layers that are filled to be semi-conductor structures, and would be excluded by the Examiner’s improper interpretation of the term “feature”. Reversal of the rejection is respectfully requested.

**II. THE EXAMINER ERRED IN REJECTING CLAIMS 1-8, 11-14, AND 21 UNDER 35 U.S.C. § 103(a) BECAUSE THE CITED REFERENCES FAIL TO TEACH, SHOW, OR SUGGEST DEPOSITING A FIRST BARRIER LAYER WITHIN A FEATURE, ETCHING THE BOTTOM OF THE FEATURE, DEPOSITING A SECOND BARRIER LAYER COMPRISING Ta, TaN, TaSiN, TiSiN, IN THE FEATURE, AND THEN DEPOSITING COPPER ON THE BARRIER LAYER.**

Claims 1-8, 11-14, and 21 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Taguchi et al.* in view of *Ho et al.*, and further in view of *Barnes et al.* and *Bunshah*, on grounds that the combination of references shows each feature of the claimed invention. Applicants respectfully traverse the rejection on grounds that the combined references do not teach, show, or suggest depositing a first barrier layer within a feature, etching the bottom of the feature, depositing a second barrier layer comprising Ta, TaN, TaSiN, TiSiN, in the feature, and then depositing copper on the barrier layer.

To determine patentability under 35 U.S.C. § 103, the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved, and the obviousness or non-obviousness of the subject matter is determined against this background. *Graham v. John Deere*, 383 U.S. 1 (1966). Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). To establish prima facie obviousness of a claimed invention, all the claimed limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974).

The rejection is initially based on *Taguchi et al.* which describes a combination of barrier layers that reduce oxidation of titanium to improve aluminum deposition. The Examiner fails to identify any suggestion or motivation for combining the aluminum deposition method of *Taguchi et al.* with copper deposition. The rejection is further based upon *Ho et al.*, which describes filling of apertures with copper, but does not suggest deposition and etching of Si<sub>x</sub>N<sub>y</sub> layers to prevent migration of metal. The rejection is finally based on *Barnes et al.* and *Bunshah* which generally relate to an apparatus for depositing copper layers and sputtering yields for various materials under argon ion bombardment, respectively, without mentioning the use of Si<sub>x</sub>N<sub>y</sub> as a barrier material. The Examiner has not cited a proper basis for combining the various barrier layer deposition steps of *Taguchi et al.* with the copper deposition steps of *Ho et al.* and techniques of *Barnes et al.* and/or *Bunshah*. Applicants are unable to further address the

Examiner's reasons for combining the references because the reasons have not been asserted. The combination of references must be based on more than identifying each element of an invention in one of the references since non-obvious combinations of old elements are patentable.

Obviousness requires some teaching or suggestion that the elements may be combined to provide the claimed invention. The combined references do not teach, show, or suggest depositing a first barrier layer within a feature, etching the bottom of the feature, depositing a second barrier layer comprising Ta, TaN, TaSiN, TiSiN, in the feature, and then depositing copper on the barrier layer as claimed by Applicants. Reversal of the rejection is respectfully requested.

**III. THE EXAMINER ERRED IN REJECTING CLAIMS 15-18 AND 20 UNDER 35 U.S.C. § 102(b) BECAUSE THE CITED REFERENCE DOES NOT TEACH, SHOW, OR SUGGEST DEPOSITING A BARRIER LAYER THAT IS ETCHED TO EXPOSE AN UNDERLAYER WITHIN A FEATURE, AND SELECTIVELY DEPOSITING A METAL LAYER ON THE UNDERLAYER TO FILL THE FEATURE.**

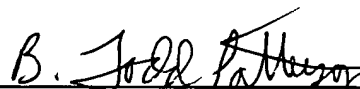
Claims 15-18 and 20 stand rejected under 35 U.S.C. § 102(b) as being anticipated by *Taguchi et al.*, on grounds that the reference discloses all elements of the claimed method for depositing  $\text{Si}_x\text{N}_y$  layers. Applicants respectfully traverse this rejection on grounds that the claims include the novel combination of depositing a barrier layer that is etched to expose an underlayer within a feature, and selectively depositing a metal layer on the underlayer to fill the feature as described in the specification for Figs. 7-11. *Taguchi et al.* describes deposition of a non-selective barrier layer on all surfaces including the underlayer followed by filling the feature with metal. The non-selective barrier layer is not etched to expose the underlayer as claimed by Applicants. Therefore, *Taguchi et al.*, does not teach, show, or suggest depositing a barrier layer that is etched to expose an underlayer within a feature, and selectively depositing a metal layer on the underlayer to fill the feature. Withdrawal of the rejection is respectfully requested.

**Conclusion**

In conclusion, the references do not teach, show, or suggest the claimed invention which

includes depositing a first barrier layer within a feature, etching the bottom of the feature, depositing a second barrier layer comprising Ta, TaN, TaSiN, TiSiN, in the feature, and then depositing copper on the barrier layer. The references further do not teach, show, or suggest depositing a barrier layer that is etched to expose an underlayer within a feature, and selectively depositing a metal layer on the underlayer to fill the feature. Thus, Applicants respectfully request withdrawal of the rejection of claims 1-8, 11-18, and 20-21.

Respectfully submitted,

  
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B. Todd Patterson  
Reg. No. 37,906  
Attorney for Applicant  
THOMASON, MOSER & PATTERSON  
3040 Post Oak Boulevard, Suite 1500  
Houston, Texas 77056  
(713) 623-4844



## APPENDIX

1. A method of filling a feature formed in a dielectric layer, comprising:
  - a) depositing a generally conformal first barrier layer in the feature;
  - b) removing the first barrier layer formed on the bottom of the feature;
  - c) sputter depositing a second barrier layer under conditions of a high density plasma, wherein the second barrier layer comprises a material selected from a group consisting of Ta, TaN, TaSiN, TiSiN, and combinations thereof; and
  - d) depositing a metal layer in the feature, wherein the metal layer comprises copper.
2. The method of claim 1, wherein the first barrier layer is deposited using chemical vapor deposition techniques.
3. The method of claim 2, wherein the first barrier layer is comprised of  $\text{Si}_x\text{N}_y$ .
4. The method of claim 3, wherein the first barrier layer formed on the bottom of the feature is removed using etching techniques.
5. The method of claim 4, wherein the metal layer deposited in the feature is copper.
6. The method of claim 5, wherein the metal layer is deposited using chemical vapor deposition techniques.
7. The method of claim 5, wherein the metal layer is deposited using physical vapor deposition techniques.
8. The method of claim 1, wherein the first barrier layer comprises  $\text{Si}_x\text{N}_y$ .

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9. (Canceled) The method of claim 8 wherein the second barrier layer comprises a material selected from the group consisting of Ta, TaN, TaSiN, TiSiN and combinations thereof.
10. (Canceled) The method of claim 9 wherein the metal layer sputter deposited in the hole is copper.
11. The method of claim 1, wherein the second barrier layer is sputter deposited under the conditions of a high density plasma.
12. The method of claim 11, wherein the metal layer is sputter deposited under the conditions of a high density plasma.
13. The method of claim 12, wherein the metal layer is heated to a temperature of between about room temperature and about 500°C and then subjected to a pressurized environment.
14. The method of claim 13, wherein the pressurized environment is in the range of about 1000 psi to about 100,000 psi.
15. A method of forming a feature in a dielectric layer, comprising:
  - a) depositing a first barrier layer over a blanket dielectric layer;
  - b) forming a feature through the barrier layer and the dielectric layer to expose an underlayer;
  - c) depositing a second generally conformal barrier layer in the feature;
  - d) removing the barrier layer formed at the bottom of the feature ;
  - e) selectively depositing a metal layer on the underlayer exposed in the feature.
16. The method of claim 15, wherein the first barrier layer and the second barrier layer are comprised of  $\text{Si}_x\text{N}_y$ .

17. The method of claim 16, wherein the first barrier layer and the second barrier layer are formed using chemical vapor deposition techniques.
18. The method of claim 17, wherein the barrier layer formed on the bottom of the feature is removed by sputter etching techniques.
19. (Canceled) An integrated processing tool, comprising:  
a central transfer chamber having a robot assembly disposed at least partially therein for moving substrates;  
a chemical vapor deposition chamber for depositing  $\text{Si}_x\text{N}_y$ ;  
a high density plasma physical vapor deposition chamber connected to the transfer chamber having a target comprising tantalum;  
an etch chamber capable of achieving a high density plasma; and  
a high density plasma physical vapor deposition chamber connected to the transfer chamber having a target comprising copper.
20. The method of claim 5, wherein the metal layer is deposited by first depositing a wetting layer using chemical vapor deposition techniques and then filling the feature using physical vapor deposition techniques.
21. The method of claim 15, wherein the metal layer is copper.